THE ANTHOZOA OF THE WOODS HOLE REGION : : : : : : : : : : By Charles W. Hargitt

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INTRODUCTORY.

The present report aims to present in convenient form a synoptic account of the Anthozoa (Actinozoa) of the region, adapted alike to the needs of the general worker in systematic zoology and those desiring in brief compass a modern survey of the habits, characteristics, and local distribution of the group.

The material forming the basis of the report has been collected for the most part by the writer at various times during the past five years, though some of the specimens of deep-water habitat were collected by the *Fish Hawk* during dredging expeditions at various times within the past 10 years. A record of these latter collections will be noted in connection with the several species concerned.

It is again my pleasure to acknowledge the assistance of Mr. Vinal N. Edwards in many ways. My thanks are also due to Commissioner George M. Bowers and to Dr. F. B. Sumner, director of the laboratory, for many courtesies.

GENERAL ACCOUNT.

Anthozoa are marine animals of various range of distribution, habit, size, etc., and variously known as actinians, sea anemones, polyps, etc. In general they are more or less sedentary, i. e., attached to some permanent support, such as rocks, piles, etc., or in some cases (Alcyonaria) rooted in the sandy bottoms where they thrive, or in still other cases (corals) forming a calcareous skeleton, which in the subtropical species gives rise to complex reef masses. Not a few of the actinians have a measure of locomotor power and creep, snail-like, over the supporting base to which they are attached. And again still others are given to a commensal mode of life, forming the well-known partnerships with hermit crabs or other creatures of similar habit. Further notice of these peculiarities will be given in connection with the species which exhibit the trait.

Anthozoa, in common with other classes of cœlenterates, may live a wholly solitary and independent life, as in most actinians, or may form highly complex colonies, as in most corals and Alcyonaria. In the case of colonial species the polyps are usually

united in more or less compact masses, the whole colony being brought into communal relations by means of a common body substance, the cœnenchyme, through which a system of gastric canals ramifies in various degrees, and thus directly or indirectly brings the various individuals into communication, both for nutritive and for protective purposes. It is most interesting to observe the sensory continuity which prevails in one of these colonies. Any irritation which disturbs one polyp is promptly conveyed to every individual of the colony, a sensory wave passing over the community not unlike that produced by the wind upon a field of grain or tall grass.

MORPHOLOGY.

In form and structure Anthozoa have many features of very considerable interest, not only to the critical student of morphology but to the casual observer or student of natural history. In form there is exhibited a wide range, from the simple polyp, of minute size and of structure hardly more complex than that of a hydrozoan, to the complexity and mass of immense communal aggregates of reef corals and sea plumes and gigantic anemones more than a foot in diameter.

In fundamentals of structure there is of course a more or less intimate homology running throughout the entire class, though with considerable ordinal peculiarities, and even generic and specific features more or less unique. The general form of the individual polyp, whether actinian or alcyonarian, is cylindrical or barrel-shaped, with a hollow gastric interior. Usually the height is considerably greater than the diameter, but owing to the highly contractile powers of the organisms these proportions vary greatly under various conditions of contraction. The body is terminated by a basal portion usually known as the foot, or pedal disk, and by an upper terminal portion, the oral disk, or peristome. The body proper is usually designated as the column. In sedentary species the pedal disk forms an organ of attachment, or in those having motile power constitutes the chief organ of locomotion. This feature is rather peculiar to the free-living species, though it may be absent in such tube-dwelling forms as *Cerianthus*.

The oral disk is characterized by the presence of a distinct mouth, which is usually of oval shape, especially in actinians, and with its edges, or lips, more or less folded or corrugated. The mouth communicates with the gastric cavity or enteron through an œsophagus, the inner end of which opens abruptly into the gastric cavity.

A series of radially arranged septa, the mesenteries, connect the inner walls of the œsophagus with those of the body, thereby forming a regular series of alternating septa and pockets, the latter ending blindly at the oral disk above, except as they may communicate with the bases of hollow tentacles, but opening freely below into the enteron. The margins of the mesenteries below their œsophageal connections are often more or less thickened, and bear filaments which are characteristic of Anthozoa. They are composed of entoderm, and are richly supplied with gland and nettling organs. In many actinians these latter organs are threadlike, highly contractile structures known as acontia, which are loaded with specialized nettling cells, and may be

thrust out of special pores, cinclides, or through improvised openings in the tissues of the body wall.

The marginal portion of the oral disk bears the tentacles, which are usually hollow outgrowths from this part of the body. They vary greatly in size and number in different species and genera. In Cerianthidæ they form two distinct sets, the circumoral, surrounding the mouth, and the marginal, corresponding to those of other orders. The latter are often designated as primary or principal tentacles; the former as accessory or circumoral.

As indicated above, the general form of the body as a whole is more or less cylindrical. Peculiarities of distinction will be considered in connection with those species exhibiting them. This will also be the case in reference to particular features of oral or pedal disks. In many of the orders some form of skeleton, calcareous or horny, is present. This is particularly the case with most corals and alcyonarians. On the other hand, most or all actinians are entirely devoid of anything of the sort.

Another feature of some significance is the habit of certain actinians to expand and inflate the pedal disk and thus convert it into a float by means of which they are able to migrate under the influence of currents, much as do certain other pelagic coelenterates (*Vesalia*). This has been observed in several local species, and it seems not unlikely that it may be of more general occurrence than might be supposed. Among those which exhibit the phenomenon may be mentioned *Sagartia luciæ*, *S. leucolena*, and *Anemonia sargassensis*. It should be stated, however, that this has been noted only in specimens in the aquarium; but its occurrence under these conditions with more or less frequency would strongly suggest its occurrence in nature under certain circumstances.

COLORATION.

In comparatively few classes of animals are there richer or more varied exhibitions of color than among Anthozoa. This is particularly striking in the tropical or subtropical species. To those who may have had the exquisite pleasure of looking upon the splendid display of colors associated with coral reefs no emphasis will be needed on this point; and to others an adequate verbal description would seem highly exaggerated. The profusion of coloration and the plantlike features of many of these cœlenterates are doubtless the occasion of such names as anemones, anthozoa, zoophytes, etc., by which many of them are known even to this day.

Into the problem of the origin or significance of colors in these lower classes no attempt will be made to enter seriously. Something of this has been done by the writer in an earlier paper (1904) and to a less extent in a report on the Medusæ of Woods Hole (1905). However, there are some points of particular phases of color involved in Anthozoa which call for notice. In the first place, it is interesting and significant that among these creatures color is due to distinctly different factors. For example, Duerden (1905) has shown that among many corals the dominant color is due to the presence of commensal algæ, *Zooxanthellæ*, which thrive in the entodermal tissues of the polyps.

In such cases the problem of color is transferred from the animal to the plant, which relieves the present discussion of any particular consideration of the matter. It may suffice, therefore, to say that in such cases color is only of secondary or incidental biological significance, and is meaningless in relation to any problem of adaptation or protection. In the words of Duerden, "The rich profusion and beauty of color in coral polyps certainly seems to have no protective or warning significance" (op. cit., p. 16).

But even in organisms in which color is constitutional there is little or no relation to environmental influences. For example, many actinians and alcyonarians living under identical conditions have very different color features; and, on the other hand, species of widely differing habitats and diverse environments exhibit closely similar aspects of coloration. Furthermore, a species which shows remarkable color variations in a given habitat will often show the same variations through its entire range of distribution. As an example of this may be cited the well-known case of the common *Metridium marginatum*. The world-wide distribution of this species (assuming with McMurrich its identity with *M. dianthus*), and the very similar aspects of coloration, illustrates the point under consideration, showing that conditions of environment or habitat have little to do with the character or variation of colors, at least so far as this species may have any significance.

The influence of conditions of nutrition, as already shown by me in former papers (op. cit.), act in similar manner on Anthozoa. Actinians kept in the aquarium very soon show color changes indicative of lowered states of vitality, unless pains be taken to obtain approximately natural conditions. In the celebrated Naples aquarium this has been more successfully done than I have seen elsewhere. Here certain species of actinians have thrived for years with little loss of vitality or change of coloration.

PHOSPHORESCENCE.

Among the many various and complex phenomena of life few are more unique or obscure than that of phosphorescence, or vital luminosity, the former name being more or less a misnomer, since except in appearance there is little or nothing in common between the phenomena to which it was originally applied, and those associated with living things. However, the term has become so generally associated with all sorts of luminous phenomena of similar appearance, and devoid of appreciable heat, that its use is likely to continue; and if care be taken to discriminate no serious confusion is likely to arise.

The occurrence of phosphorescence in many species, and in a wide range throughout the entire class, makes some reference to the subject more or less incumbent. While probably much more general in tropical and subtropical waters it is yet fairly common elsewhere, being well known throughout the region concerned in this report.

Much speculation has been aroused concerning its use or significance, and various and conflicting theories projected. No attempt will be made here to review the subject historically, nor to cite the various differences of opinion which have grown up.

Among the older students of cœlenterates Johnson and Forbes made observations and experiments in connection with the subject, and in turn cite similar observations made by Ehrenberg, Spallanzani, and others, showing no less interest than has been common in later times.

Macartney proved by experiments that the phenomenon might be aroused by a wide variety of stimuli, such as temperature, mechanical disturbance, chemical agents (as alcohol), electricity, etc. Forbes was able to confirm certain of these results, and also proved that in the phenomenon there was no evidence of electrical discharge, and further that no heat was evolved in connection with the emission of light.

Allman also studied the subject in connection with hydroids. He found the phenomenon exhibited by various calyptoblastic hydroids, but not in any known gymnoblastea. Like other observers, he found that various physical and chemical stimuli were needed to evoke displays of light. He was not able to find any phosphorescent secretion in the hydroids, such as had been found in connection with insects and other phosphorescent organisms.

Among Anthozoa its occurrence has been best known in groups of alcyonaria, especially in species of *Pennatula*, *Gorgonia*, etc., but not unknown in such solitary forms as the actinians. In the latter it has been observed chiefly in the slimy secretion of the ectoderm.

Reference has already been made to the conflicting theories as to the significance of phosphorescence. A few words must suffice on this point. It was suggested by both Carpenter and Thomson that it might have some importance as a source of abyssal light, thus affording some means by which the inhabitants of the darkness of great depths might be aided in finding food, evading enemies, etc. But, on the other hand, Mosely has pointed out the inadequacy of such a view. Many facts seem utterly in conflict with the theory. For example, the light of organisms from these depths has been found to be more or less monochromatic, or of only two or three colors. This would suggest that other colors would be invisible under such light, hence incompatible with the theory. He concludes that colors of deep-sea forms are probably only incidental, or features persisting from earlier conditions when the creatures were inhabitants of shallow waters. And on this and similar grounds he adduces a strong argument as to the comparatively recent migration of many of the abyssal forms into their present habitat.

Verrill has suggested that phosphorescence might serve as a warning to predaceous fishes that luminous organisms were provided with weapons of defense which it were well to evade. A. Agassiz has pertinently suggested that the well-known cases of *Physalia*, *Cyanea*, etc., and their commensals, and the habits of many fishes of feeding constantly in the coral and alcyonarian forests, all went to prove that "they are not in dread of lasso-cells." Among the most brilliantly phosphorescent of our local fauna are ctenophores. But it is well known that these are fed upon by a number of fishes. It may be safely assumed, therefore, that Verrill's suggestion is utterly without significance as an explanation.

More recently Nutting has suggested the ingenious view that phosphorescence may serve as a lure, attracting copepods and various larvæ within reach of the luminous organism. "The process would be analogous, perhaps, to what is known as the effect of alluring coloration among insects and birds. The phosphorescence would thus be of direct utility to the fixed cœlenterates in securing food." Unfortunately, there is no more evidence in support of this than in that of Prof. Verrill. And on the other hand, there is much which goes to show that such a view is directly in conflict with too large a mass of facts to render it at all probable. Such are the facts of phosphorescence in littoral forms, and in free-swimming and surface forms, whose modes of taking prey render it highly improbable that they have any need of such an aid. Phosphorescence is not solely a property of deep-sea life nor of nocturnal feeders. The writer regards it as associated with processes of metabolism; and while not beyond the realm of utility to the organism it is not directly so. Theories dealing with the subject have been propounded on the assumption that every vital feature and phenomenon must be brought into alignment with natural selection. It is to be hoped that we are emerging from the shadow of that assumption.

REPRODUCTION.

Generation in this class, as in others of the phylum, is both sexual and asexual, though without the more or less rhythmic alternation of generations so characteristic of the Hydrozoa. The sexual products are borne on certain of the mesenteries, and when ripe are usually extruded through the mouth. In some species, however, development may take place within the mesenterial chambers, and the young later discharged in a fully formed condition. The sexes are usually distinct, as in most Hydrozoa, but may be united in a single individual in certain species. That is, Anthozoa may be either diœcious or monœcious—unisexual or bisexual. Duerden has shown (1904), in the case of certain corals, that the bisexual or hermaphrodite condition may prevail, a given individual producing both ova and sperms, though not at the same time. That is, the genital products mature at somewhat different intervals, the organism being protogynous, maturing the ova first; or it may be protandrous, maturing the sperms first.

Asexual propagation is of general occurrence and of great importance. It is chiefly by the process of budding; though fission is not unknown among actinians, a given specimen dividing longitudinally, much as in *Vorticella*. Parker (1897, Bulletin of Museum of Comparative Zoology, p. 43) has described this process in *Metridium marginatum*, and Torrey has shown the same in the case of *M. fimbriatum* (Proceedings California Academy of Sciences, vol. 1, p. 345, 1898). The writer has observed the entire process take place in *Sagartia luciæ*, a small but extremely interesting anemone of our coast. In this species fission is apparently a common feature of reproduction. In text figure 1 is shown a sketch of a *Metridium* in process of fission. Such specimens are not particularly rare. Still another mode of asexual reproduction is more or less familiar, namely, that known as fragmentation. It consists of the formation of numerous minute individuals by a sort of indefinite budding from the margins of the pedal disk. This process seems

to be rather common in *Metridium marginatum*, as I have found many cases occurring, both in the aquarium and in a state of nature. Torrey (op. cit.), has suggested that it may be due to the unfavorable conditions of the aquarium, but its occurrence in natural conditions as just cited would preclude this as a cause.

DISTRIBUTION.

Anthozoa are of wide distribution, both in time (geological) and in space (geographical), and also in bathymetrical range. Of the first, or geological, it is not within the scope of the present paper to take notice. Of geographical range it may suffice to say that, like the former, a general consideration of the problem is not designed in the present review. Many conditions are involved in the matter of distribution, among which temperature plays an important part. This is particularly the case with alcyonaria, which are predominantly tropical or subtropical organisms. The same may also be said of the coral group, or Zoanthariæ.

In bathymetrical range there is great variation among the several groups. Many of each have been dredged from great depths, but by far the larger number have their habitat in shallower seas and along shore lines. In certain cases a given species may find itself equally at home in depths of from 50 to 1,500 fathoms. *Bathyactis* is recorded as being found in depths of from 50 to 3,000 fathoms.

ECONOMIC RELATIONS.

In common with cœlenterates in general, the economic relations of Anthozoa are chiefly incidental and indirect. A few fishes are known to feed on corals, a few on hydroids, perhaps still fewer on alcyonarians or others. So far as I am aware, actinians are usually immune from predatory attacks. Furthermore, certain actinians may serve as hiding places for small fishes, which have established commensal relations with them. On the other hand, not a few actinians feed upon fishes more or less freely. The commensal relations of actinians and hermit crabs are well known.

Indirectly corals have played a very important part in the contour of islands and continents from Paleozoic to recent times. And at present in subtropical regions these organisms are constantly concerned in the extension of certain coast lines by the formations of reefs along its margins. Thus, may be reclaimed something of the areas constantly being lost through erosion and transportation of continental débris into the seas; but, on the other hand, growth of these organisms in harbors and roadways of steamships often involve obstructions and dangers hard to overcome.

SYSTEMATIC ACCOUNT.

In common with that of other classes of cœlenterates, existing conditions of taxonomy of Anthozoa are not highly satisfactory. Several attempts at revision have been made within comparatively recent times, but much yet remains to be done before an orderly and adequate system of classification will be established. Among those who

have contributed materially to this end may be mentioned the following: Hertwig, R. and O. (1879); Hertwig, R. (1882); Andre, A. (1884); McMurrich, J. P. (1894); Van Beneden (1897); Carlgren (1900). These works are devoted almost exclusively to the Actinozoa. Similar work upon the Alcyonaria has been done by May (1899), Kukenthal (1905), and Studer.

While it is no part of the purpose of this report to enter into the matter of taxonomy in any detail, it may not be amiss to include brief synoptic tables indicative of opinion as to this phase of our subject, at least, as relates to Actiniaria. A valuable review of the history of taxonomic development along this line may be found in the report of McMurrich on the Actiniæ of the *Albatross* Expedition (Proceedings, U. S. National Museum, vol. XVI, 1893, p. 119–135). Brief historical references are also made by Hertwig (*Challenger* Report, vol. VI, p. 16–18) to this phase of the general subject, though with no attempt to trace the development of taxonomic systems.

Concerning the systems proposed by Van Beneden (1897) and Carlgren (1900), it is hardly within the scope of this paper to undertake an adequate review. Both are noteworthy contributions and will command the attention of specialists everywhere. They involve, however, considerable of embryological and histological details and methods, and are hence somewhat too technical for use in the present instance.

Under almost all modern systems of classification the musculature of the body has constituted one of the most important taxonomic characters. It becomes necessary, therefore, to devote some further attention to this feature. As to their relations, the muscles may be said to be ectodermal, entodermal, or mesodermal, as they are associated with these several tissues. The musculature is disposed chiefly in two positions, namely, (1) as longitudinal fibers distributed to the walls of the column; (2) as circular bands distributed variously over the body. Of the latter there is usually a special development in the oral region known as the sphincter. This acts as an organ for closing the mouth, much as one might close the opening of a bag by a draw string.

R. Hertwig has emphasized the importance of various aspects of the musculature as taxonomic features and says:

> The nature of the sphincter varies greatly. We talk of a diffuse sphincter when it arises from repeated pleatings of the muscular lamella; in that case because it is not sharply defined at the upper and lower margins, it does not strike the eye in looking at the surface, and is shown in transverse sections only by the local thickening of the wall in whose substance it is completely embedded. A circumscribed sphincter is formed when the pleated muscular mass projects above the inner surface of the wall, with which it is connected only by a narrow band, so that an annular swelling arises which is easily observed both in looking at the surface and in transverse section.
>
> Finally, in the mesodermal sphincter, the muscles have left their original position in the epithelium and are completely hidden in the supporting substance, which consequently increases doubly or trebly in thickness. The complete absence of the sphincter is comparatively rare. I have only observed it in a few species, almost invariably animals which are not capable of contracting the upper margin of the wall over the oral disk. This is, however, also the case in animals with a weak sphincter, such as the Antheadæ. On the other hand, the existence of a strong circular muscle can often be inferred with tolerable certainly from a high degree of contraction. The capacity for concealing the oral disk plays an important part in the systematic division of the Actiniaria; this is generally most inappropriately expressed by the term "retractile tentacles." It would be decidedly more rational to make the ana-

tomical reason, and not the physiological appearance, of systematic value. We shall therefore talk of Actiniaria without sphincter, and Actiniaria with weak and with strong sphincter, and further distinguish in the latter case whether the muscle is entodermal or mesodermal.

The systematic value of the circular muscle does not end here, as it furnishes a character not to be undervalued for determining the species. * * * I lay stress upon this point, as the circular muscle can be examined in the preserved animals even when their state of preservation is not very favorable, and because, moreover, a small piece of the wall, which can be cut away without essential damage to the whole animal, is sufficient for such an investigation. (Challenger Report, vol. VI, p. 6–8.)

Class ANTHOZOA.

The class Anthozoa, as limited in this synopsis, comprises some two well-marked subclasses, namely, the Alcyonaria and the Zoantharia. A third subclass, the Rugosa, includes only fossil forms, which makes it undesirable to cumber the present report with any account of it.

Each of the two subclasses above named comprises in turn three rather well differentiated orders, all, with a single exception to be named later, having representatives among the local species. The following synopsis of orders may serve as a formal introduction to the taxonomy of the Anthozoa.

ALCYONARIA.

The order Alcyonaria includes those members of the class Anthozoa which are characterized by the presence of eight pinnate tentacles and a corresponding number of mesenteries. All are of marine habit, and most are colonial, forming more or less complex clusters of polyps united to a common stock, and with or without definite skeletal structures. In most cases, however, there is a skeleton composed of calcareous spicules of various form and color giving to the colonies the characteristic spiny surface of many gorgonians and similar forms.

The distribution of these spicules may be somewhat general throughout the tissues of the body, or they may be aggregated into a dense axis as in the so-called black and red corals and in the familiar sea fans, etc.

ORDERS OF ALCYONARIA.

I. ALCYONACEA.—Colonial, with a well developed anastomosing canal system. Stem usually devoid of axial skeleton, but the cœnenchyma bearing numerous separate spicules.

II. PENNATULACEA.—Colonial, with a stem loosely attached in mud or sand, and capable of some degree of locomotion; an axial skeleton extends through the stem in most cases, though lacking in not a few. A specialized portion of the stem, the rachis, bears the polyps either as sessile individuals, or on numerous pinnæ which branch from the rachis, as in the familiar sea pens.

III. GORGONACEA.—Colonial, firmly attached by root-like bases or holdfasts. Stem and branches with definite axial skeleton of calcareous or horny character, overlaid by a cortical cœnenchyma from which the polyps arise.

ZOANTHARIA (Hexactinia).

Polyps and polyp colonies chacterized by simple or unbranched tentacles in one or more cycles about the mouth. Paired mesenteries usually in some multiple of six, though exceptions to this are more numerous than formerly supposed.

ORDERS OF ZOANTHARIA.

I. ACTINIARIA.—Polyps solitary, or rarely colonial, devoid of any skeletal structures, and usually adherent by a suctorial or adhesive base, the pedal disk, though capable of more or less locomotion. Mesenteries in most cases paired and in multiples of six.

II. MADREPORARIA.—Polyps colonial, or rarely solitary, and with a dense calcareous skeleton, forming, in most cases, a complex corallum.

III. ANTIPATHARIA.—Colonial zoantharia, usually with a hollow, branching skeleton of horny nature. So far as known, no representatives of this order occur in the region, which obviates the necessity for further account of it in this report.

SYNOPSIS OF TRIBES OF ACTINIARIA.

EDWARDSIAE R. Hertwig, 1882.

Noncolonial Actiniaria with eight mesenteries, two pairs of which are directives; others unpaired, and their longitudinal muscles face the same direction; all mesenteries gonad bearing. Tentacles simple, few in number, usually more numerous than the mesenteries, varying from 12 to 36. Column more or less linear and cylindrical, often fluted along the lines of attached mesenteries.

ZOANTHEAE R. Hertwig, 1882.

Colonial Actiniaria, with numerous mesenteries of two sorts, namely, small, incomplete, and devoid of gonads; large, complete, and gonad bearing. A single œsophageal groove. Outer surface of body usually incrusted with a coating of sand or other foreign particles. Tentacles simple.

CERIANTHEAE R. Hertwig, 1882.

Actiniaria with numerous, unpaired mesenteries, except a single pair of directives, which are very short and attached to the deep œsophageal groove. On either side of these will be found the much longer perfect mesenteries, which increase in size in regular order to the opposite (dorsal) side. Tentacles numerous and in two series—an outer principal and an inner accessory series—the circumoral tentacles. Body elongate, usually inclosed in a slimy flexible tube. Aboral end of body rounded and provided with a terminal pore.

HEXACTINIAE R. Hertwig, 1882.

Actiniaria with six or more pairs of primary mesenteries. Other cycles arise in pairs, some of which may become perfect, others incomplete. The primary mesenteries are provided with retractor muscle fibers on their inner faces i. e., the muscles of each pair facing the intramesenterial space. There are usually two œsophageal grooves, with directive mesenteries, whose muscles face outward, or opposite the aspect of the other pairs. Body more or less smooth, often with longitudinal furrows, and in certain cases with wartlike nodular processes, verucæ. Tentacles usually numerous and of various characters.

The above tribal characteristics have been variously compiled from those given by Hertwig, McMurrich, Haddon, Duerden, and Gosse, and to a less extent from Andres, Verrill, and others.

FAMILIES OF HEXACTINIÆ.

ILYANTHIDÆ Gosse (in part), 1858.

Body usually elongate, cylindrical, aboral end rounded and with somewhat constricted, bulblike physa, but devoid of definite pedal disk. Tentacles simple and relatively few in number, or in some cases numerous; sphincter weak.

There is considerable uncertainty as to the constitution of this family, some authorities even excluding it altogether. Gosse, who established it, included under it the Edwardsiæ as well as the Cerianthæ. Hertwig considers the family as intermediate between the Edwardsiæ and true Hexactiniæ, and so ranks them in his system. (Op. cit., p. 92.)

ANTHEIDÆ Gosse (in part), 1858.

Hexactiniæ with well-developed pedal disk, often capable of expansion and inflation as a pneumatophore. (Cf. Gosse, Actinologea Britannica, p. 149.) Column generally smooth, sometimes with verucæ; tentacles long, very flexible, and disposed chiefly about the margin of the disk; mesenteries numerous; sphincter muscle very weak, rendering difficult any considerable contraction of disk or tentacles.

SAGARTIIDÆ Gosse, 1858.

Body with strong oral sphincter and numerous highly contractile tentacles. Mesenteries of two sorts; principal series in six pairs attached to œsophagus, and devoid of gonads; second series incomplete, and bearing gonads in breeding season. Acontia present and protrusible through cinclides or directly through the tissues.

BOLOCERIDÆ McMurrich, 1893.

Sphincter more or less diffuse and weak; mesenteries devoid of acontia; pedal disk well developed; tentacles stout, nonretractile, strongly constricted at base, hence often deciduous.

BUNODIDÆ Gosse, 1858.

Sphincter entodermal, "body usually studded with numerous tubercles, which are disposed in longitudinal rows, and may serve as suckers by means of which they have the faculty of adhering with force to foreign bodies." (Gosse.) Mesenteries often numerous and perfect but devoid of acontia.

PARACTIDÆ Hertwig, 1882.

Sphincter mesogleal, strong; body usually devoid of tuberculation, but with numerous longitudinal flutings; mesenteries numerous and perfect; no acontia.

TEALIIDÆ Hertwig, 1882.

"Hexactinia with numerous perfect mesenteries; sphincter strong, entodermal, projecting as a thick swelling into gastric cavity."

"The most important feature of the family is, I consider, the extremely characteristic circular muscle, which can be recognized with the naked eye, as a thick swelling on the inner side of the wall. In transverse section it shows a circular or oval figure, fastened on one side to the wall; it is formed by the extremely strong pleating of the entodermal circular muscle layer. The large number of perfect septa is also important; on the other hand, I have entirely disregarded the nature of the surface of the body, so that forms both with smooth and warty wall may find their place in the family." (Hertwig, op. cit., p. 35.)

Diagnostic Synopsis of Families of Hexactiniæ (modified from Hertwig).[a]

A. Tentacles forming simple wreath.
- *a*. Digitate.
  - *b*. Pedal disk absent.
    - *c*. Siphonoglyphs and sphincter obscure
      - Without conchula ..... Ilyanthidæ.
      - With conchula ..... Siphonactinidæ.
  - *bb*. Pedal disk present.
    - *d*. Acontia present, sphincter mesodermal, cuticular covering
      - Absent .. Sagartiidæ.
      - Present .. Phelliidæ.
    - *dd*. Acontia absent, sphincter
      - Absent ..... Antheomorphiidæ.
      - Present
        - Weak ..... Actiniidæ.
        - Strong entodermal ..... Bunodidæ.
        - Strong mesodermal ..... Paractidæ.
        - Mesodermal, transverse axis elongated ..... Amphianthidæ.
- *aa*. Tentacles abnormal in shape.
  - *e*. Clavate, knobbed ..... Heteractidæ.
  - *ee*. Replaced by stomidia ..... Liponemidæ.
  - *eee*. Branching or bushy
    - Sarcophianthidæ.
    - Thalassianthidæ.

B. Tentacles form double or multiple wreaths ..... Corallimorphidæ.

[a] Cf. Challenger Report, vol. xxvi, pt. 73, p. 7.

DIAGNOSTIC SYNOPSIS OF FAMILIES OF HEXACTINIÆ (adapted from McMurrich).[a]

A. Tentacles in cyles—Actininæ.
  a. Column simple.
    b. Tentacles cylindrical, smooth.
      c. Sphincter absent or weak { Mesenteries not numerous ..... HALCAMPIDÆ.
                                    { Mesenteries numerous ..... ANTHEIDÆ.
      cc. Sphincter entodermal, tentacles deciduous ..... BOLOCERIDÆ.
      ccc. Sphincter mesodermal { Acontia absent ..... PARACTIDÆ.
                                  { Acontia present ..... SAGARTIIDÆ.
      cccc. Sphincter entodermal, circumscribed { Acrorhagi wartlike ..... BUNODIDÆ.
                                                  { Acrorhagi foliate ..... PHYLLACTIDÆ.
    bb. Tentacles warty or branched { Simple ..... HETERACTIDÆ.
                                      { Compound ..... THALASSIANTHIDÆ.
    bbb. Tentacles reduced to stomidia { ..... POLYOPIDÆ.
                                         { ..... SICYONIDÆ.
  aa. Column in upper part with branched or globular processes ..... DENDROMELIDÆ.
B. Tentacles radially arranged—Stychodacylinidæ.
  a. Tentacles of one form { Few, capitate ..... CORALLIMORPHIDÆ.
                             { Numerous, cylindrical ..... DISCOSOMIDÆ.
                             { Nodulated ..... AURELIANIDÆ.
  aa. Tentacles of two forms { Marginal cylindrical, disk tentacles wartlike, branched or foliate ..... RHODACTIDÆ.
                               { Marginal pinnate, disk tentacles wartlike ..... PHYMANTHIDÆ.
  aaa. Tentacles of various forms, not cylindrical ..... CRIPTODENDRIDÆ.

METRIDIUM Oken, 1815.

Metridium dianthus (Ellis), Oken. [Text fig. 1.]

Actinia dianthus Ellis, Phil. Trans., vol. 57, 1767.
Metridium dianthus Oken, Lehrb. der Naturgesch., 1815.
Actinia marginata Lesueur, Jour. Nat. Sci., Phil., vol. 1, p. 172, 1817.
Metridium marginatum Milne-Edwards, Hist. Nat. des Cor., vol. 1, p. 254, 1857.
Actinia marginata L. Agassiz, Cont. Nat. Hist. U. S., vol. III, 1860.
Actinoloba dianthus Gosse, Brit. Sea Anem., p. 12, 1860.
Metridium fimbriatum Verrill, Mem. Boston Soc. Nat. His., vol. 1, 1864.
marginatum Verrill, Inv. An. Vineyard Sound, p. 444, 1874.
dianthus McMurrich, Ann. N. Y. Acad. Sci., vol. XIV, 1901, p. 3. Torrey, Proc. Wash. Acad. Sci., vol. IV, 1902.
(For full details of synonymy, see Andres, 1883.)

This beautiful actinian, often designated as the "fringed sea anemone," is altogether the most common and at the same time the most conspicuous of our actinian fauna. It abounds almost everywhere from New York to Nova Scotia, from tide pools to a depth of 75 fathoms and beyond, and is one of the largest anemones of the region.

It is a remarkably variable species. This pertains to almost every aspect of the creature—size, color, habitat, structure, mode of propagation, etc. In distribution it seems to be almost cosmopolitan, being found upon both the eastern and western coasts of America, and variously over the European coasts.[b] It may be doubted whether another of its relatives has a range of distribution at all comparable.

[a] Cf. Proceedings U. S. National Museum, vol. XVI, p. 134.

[b] In identifying the local species with *M. dianthus* of Oken, I am but following several well-known authorities, especially McMurrich, vide supra.

It may not be out of place to briefly glance at certain features of variation more or less common. In color it varies from yellowish brown, which is the more common, to orange, pink, white, or various combinations of these, in stripes, mottlings, etc. McMurrich has pointed out an apparent tendency in the coloration to assume some three types, brown, orange or salmon, and white, and has suggested a correlation as to age, modes of reproduction, etc.

Parker (1897) has also proposed similar suggestions as to this and other aspects of variation.

Duerden, whose work on Anthozoa is well known, has in a recent paper suggested the influence of light as a factor affecting color varieties.

In a still more recent paper Torrey (1902) has undertaken to ascertain more certainly the factors concerned in this and other aspects of variation, especially as it relates to this species along the Pacific coast. He concludes that as yet it is impossible to ascribe it to any definite known cause.

Body cylindrical, smooth, capable of a high degree of contractility; disk well defined, with distinct marginal lobes which are abundantly supplied with short, pointed tentacles.[a] In full expansion this actinian is a most exquisite creature, beautiful and plant like, and meriting the title "the fringed anemone," often applied to it. The disk is smooth and more or less concave. Mouth rather prominent, with corrugated, or tuberculate-lips, and with well-marked œsophageal grooves, often with but one, and more rarely with three or several. Parker has directed particular attention to this feature of variation, as has also Torrey. (Cf. op. cit., supra.)

FIG. 1.—*Metridium dianthus.* Specimen in process of fission.

As an explanation of this feature the suggestion has been made that it may have its origin in the process of fission, often involved in asexual reproduction. Torrey doubts the validity of this view. In text figure 1 is shown a careful drawing of one of these twin anemones in process of fission. A brief reference has been made in an earlier connection to this aspect of reproduction. In this connection may also be noted the process known as fragmentation, the origination of small individuals by a sort of budding process of portions of the margin of the pedal disk. This is frequently observed in specimens in the aquarium, but I have found it occurring also in specimens taken from piles about the docks, making it quite certain that it is not due to any unusual or abnormal conditions.

The pedal disk is strongly adhesive and capable of being used as an organ of locomotion, the creature creeping with a slow, snail-like movement from place to place. The mesenteries are abundantly supplied with acontia, which are protruded in profusion from both the mouth and through cinclides when a specimen is irritated. The sphincter is mesogleal and strongly developed, enabling the creature to contract in a most remarkable degree. Mesenteries very numerous in adult specimens and more or less variable as to number and arrangement.

Distribution and habitat: As has already been pointed out, the range of this species is very wide. It may be doubted whether any other known species has quite so remarkable a distribution. It is found abundantly throughout the region of Woods Hole and along the entire New England coast. Its habitat is in keeping with the range of distribution. It abounds in tide pools, upon rocks, piles, shells, algæ, etc.

[a] Tentacles of inner or oral series larger, attentuate in form, and often marked by transverse bars or rings of opaque whitish color.

HALCAMPA Gosse, 1858.

Halcampa farinacea (Verrill), Andres.

Edwardsia farinacea Verrill, Am. Jour. Sci., vol. 42, 1866, p. 118; Inv. An. Vineyard Sound, 1873, p. 510, 739.
Halcampa farinacea Andres, Fauna u. Flora Golfes Neapel, bd. IX. Parker, Am. Nat., vol. XXXIV, 1900, p. 750.

This species has been reported by Verrill as occurring off Gay Head in 19 fathoms. Its chief range, however, seems to be north of Cape Cod. The present writer has not taken it in the Woods Hole region. The following brief description is chiefly compiled from that of Verrill (vide supra): "It is a cylindrical species, about an inch long, and from 0.10 to 0.12 inch in diameter, remarkable for having only 12 tentacles, which are equal, unusually short, thick, and blunt." Tentacles rather translucent, with transverse bars on inner side of brownish bands or spots. Alternating with these are bars or spots yellowish or white. Disk pale yellow, varied with small brown spots, mostly forming radial rows from mouth to tentacles.

Habitat: Found only on muddy bottoms.

EPIZOANTHUS Gray, 1867.

Epizoanthus americanus Verrill.

Zoanthus parasiticus Verrill, Mem. Boston Soc. Nat. Hist., vol. I, 1864, p. 34.
Epizoanthus papillosus Gray, Proc. Zool. Soc. Lond., 1867, p. 237.
americanus Verrill, Am. Jour. Sci., 2d ser., 1871, p. 361; Inv. An. Vineyard Sd., 1873, p. 446, 510; Bull. Mus. Comp. Zool., vol XI, 1883, p. 60.
paguriphilus Verrill, Am. Jour. Sci., 1882, p. 137; Bull. Mus. Comp. Zool., vol. XI, p. 61.
parasiticus Hertwig, Rept. Chal. Exp., vol. VI, 1882, p. 116.

This interesting actinian is one of very few among our fauna having a definitely colonial habit. The species has a rather extended range of distribution, as may be inferred from the above list of references, and the recorded localities from Maine to Maryland. It is also more or less abundant, Verrill reporting "many thousands of specimens taken off Nantucket, Marthas Vineyard," etc. Its range of depth seems to be from 25 to 400 or more fathoms. The species, while most familiar in association with the hermit crab, has apparently considerable variability as to habitat. Verrill has reported them as in some cases investing the tubes of Hyalinœcia, in others forming a similar investment of stems or branches of *Paramuricia grandis*. Those taken in the Woods Hole region have all been associated with hermit crabs. Several species have been described, among them *E. parasiticus*, *E. papillosus*, *E. americanus*, *E. paguriphilus*, etc.; but it is safe to say that among these several are identical. And it may be doubted if of the entire list herein referred to there is hardly more than varietal distinction, the variation expressing for the most part the influence of the varying habitats of the examples concerned.

The many excellent figures of the species easily available in the reports of Verrill, Hertwig, and others, obviate any special necessity for a duplication in this report.

PARACTIS Milne-Edwards, 1857.

The genus was established by Milne-Edwards and has been distinguished by the following characters, given in merest outline: Body smooth, devoid of papillæ or marginal spherules, numerous longitudinal furrows on the column; tentacles of about the same size and character.

Paractis rapiformis (Lesueur).

Actinia rapiformis Lesueur, Jour. Acad. Nat. Sci., Phil., 1817, vol. I.
Paractis rapiformis Milne-Edwards, Hist. Nat. des Corallaires, 1857, p. 249.
Actinia rapiformis Verrill, Mem. Boston Soc. Nat. Hist., vol. I, 1864, p. 35.
Paractis rapiformis Verrill, Inv. An. Vineyard Sound, 1873, p. 363, 738; Am. Jour. Sci., vol. III, p. 436. Andres, Le Attinie, Fauna u. Flora Golfes Neapel, bd. IX 1883, p. 262. McMurrich, Stud, Biol. Lab. Johns Hopkins Univ., vol. IV, p. 62.
Ammophilactis rapiformis Verrill, Am. Jour. Sci., 1899, vol. VII, p. 213. Parker, Am. Nat., 1900, vol. XXXIV, p. 753.

This species has not been taken by the present writer but is known to occur within the region. According to Verrill, its distribution ranges from North Carolina to Long Island Sound. The following brief description is taken from that of Verrill and may serve as a summary of the chief characters of the

species: "Surface nearly smooth, slightly sulcated lengthwise, color pale flesh color, or pink, translucent. Tentacles numerous, short, tapering, pale greenish olive, with dark band around the base, connecting with a dark line radiating from mouth." To this the author adds that its size when extended is 3 or 4 inches long, by about 1 inch in diameter.

BICIDIUM L. Agassiz, 1859.

Bicidium parasitica Agassiz [text fig. 2].

Bicidium parasitica L. Agassiz, Proc. Boston Soc. Nat. Hist., vol. VII, 1859, p. 24; Verrill, Mem. Boston Soc. Nat. Hist., vol. I, 1864, p. 31; E. C. and A. Agassiz, Sea-side Nat. Hist., 1865, p. 15.
Peachia parasitica Verrill, Proc. Boston Soc. Nat. Hist., vol. X, 1866, p. 338; Inv. An. Vineyard Sd., 1874, p. 739.
Philomedusa parasitica Andres, Le Attinie, 1884, p. 112.

Though reported by Agassiz and Verrill as more or less common in its relation as a parasite or commensal on *Cyanea arctica*, the writer has not found it on any specimens taken at Woods Hole. Verrill also reports it as having been found buried in gravel at low water at Eastport, Me. So far as I am aware, it has not been reported south of Cape Cod. Not having seen living specimens of the species the following description is compiled in part from the accounts of Agassiz and Verrill, and in part from specimens loaned by Mr. George M. Gray, who collected them at Eastport, Me. The figure was drawn from these specimens.

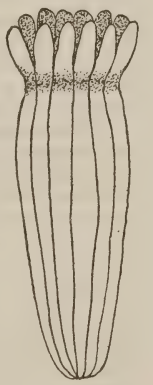

FIG. 2.—*Bicidium parasiticum.*

Figures of the shape as given differ somewhat, that of A. Agassiz showing a rather large oral end, and tapering to a rather small rounded point at the aboral. According to Verrill, it is more nearly barrel shaped. The size is about 35 mm. in length by about 10 mm. in largest diameter. Body with longitudinal furrows and "transverse wrinkles, by means of which it fastens itself securely among the fluted membranes around the mouth of the jellyfish." It is said to live for some time in confinement, where it attaches itself "for its whole length to the vessel in which it is kept, and clinging quite firmly if any attempt is made to remove it." This mode of adherence may be taken to imply the presence of such suckers as are more or less common in several other species of actinians. According to Verrill, it resembles very closely species of *Peachia* as described by Gosse.

ANEMONIA Risso, 1826.

Anemonia sargassensis Hargitt. [Pl. XLI, fig. 3.]

Anemonia sargassensis Hargitt, Biological Bulletin, vol. XIV, p. 117, 1908.

This anemone was briefly described in a recent note (vide supra), and some reference made to its habitat. Several other points call for further elucidation. Figure 3 of plate XLI shows well the general aspects of the creature and its mode of attachment to the gulf weed which forms apparently its chief or only habitat. The figure was made from life and gives approximately the color and aspects of average specimens. The base is adapted to clasping the stems of the weed to which it adheres with great tenacity. It is also able to creep along from place to place by means of the disk, though it does this only occasionally. A specimen in the aquarium was observed to remain in one identical spot for more than 30 hours. Another feature, more or less rare, is that of inflating the pedal disk, and thus making of it a float by means of which the creature may drift oral end downward, indefinitely. Duerden (1902) reports a similar habit in *Bunodosoma spherulata*, *Bunodeopsis antilliensis*, and cites observations of Duchassaing and Michelotti of a similar trait in *Cystiactis eugenia*. I have occasionally observed the same thing in several other actinians, but only in the artificial conditions of the aquarium; and it may not yet be improbable that this has something to do with the performance, yet its occurrence in nature may not be unusual. (Cf. also Gosse on this feature, p. 144.)

In 1833 Quoy et Gaimard, Voyage de l'Astrolabe (Zoologie, t. IV, p. 146), described a species, *Anemonia pelagica*, having several points in common with that here under discussion; for example, its pelagic habitat, "Trouvée sur des *fucus* au milieu de l'Ocean Atlantique;" also the prehensile nature of the tentacles. Their description is, however, very vague and Andres regards the species as doubtful. Moreover, as compared with *A. sargassensis* it has many points of difference, such as color, number of tentacles, etc. (Cf. Milne-Edwards et Haime, Histoire Naturelle des Corallaires, t. I, p. 235).

The following may be regarded as diagnostic characters: Column short and rather broad, in about the relation of 1 to 2, more or less fluted; pedal disk well developed and adapted to clasping stems of the weed; oral disk marked by radiating lines of flake white, or cream-colored lines varying in size and extending upon bases of tentacles; tentacles cylindrical, long and tapering, but slightly contractile, of various sizes and disposition about the margin of the disk; tentacles highly prehensile, and more or less adhesive, both of which characters seem of great importance as a means of catching prey, and in locomotion; tentacles variable in number, from 25 to 30 in smaller specimens to 50 in larger, and from 5 to 15 mm. in length, inner series nearly twice diameter of disk; in several cases bifurcated tentacles were observed. Tactile sense highly developed in larger tentacles.

Dimensions of body: An average of about 5 to 6 mm. high by 9 mm. in diameter. Color is various, though light brownish to chestnut or olivaceous tints are predominant. These with the whitish lines of disk and tentacles give a simulation to the color of the Sargassum in a most remarkable degree, so much so that unless careful scrutiny is made the specimens are certain to be overlooked. This feature they seem to share in common with many of the Sargassum fauna.

Acontia seem to be entirely lacking, no amount of irritation being able to secure their discharge; subsequent sections likewise failed to reveal their presence.

Primary mesenteries, six pairs (see pl. XLI, fig. 3). The figure was drawn from a small specimen, and the secondary mesenteries are only slightly developed. Directives quite well marked as shown.

Sphincter very weak or lacking, rendering contraction slight, in no case sufficient to withdraw the tentacles or wholly cover the oral disk. Body quite smooth, except for the slight vertical fluting referred to above; no tubercles or marginal spherules.

SAGARTIA Gosse, 1858.

According to Hertwig (Challenger Rept., vol. VI, pt. XV, p. 72), the genus *Sagartia* should be limited to those "*Sagartidæ* with smooth wall and numerous powerful tentacles arranged in several rows; without anatomically perceptible sinclides." This definition excludes several forms which have been hitherto usually referred to this genus, among them at least one of our local species, namely, *S. leucolena*, which has been referred by Andres to the genus *Cylista*.

Sagartia modesta Verrill. [Pl. XLII, fig. 5, 6; XLIII, fig. 7.]

Sagartia modesta Verrill, Proc. Boston Soc. Nat. Hist., vol. X, 1866, p. 337; Inv. An. Vineyard Sound, 1874, pp. 330, 738. Andres, Fauna u. Flora Golfes Neapel, bd. IX. Parker, Am. Nat., vol. XXXIV, 1900.

Body elongate, cylindrical, in expansion about five times longer than in diameter. Pedal disk more or less evident, effective as an organ of adhesion, by means of which it attached itself to a rock or other substratum. This may be best observed in a small aquarium, or by careful examination of specimens when first taken from the normal habitat, adherent to some supporting base. Tentacles are numerous, from 60 to 100, more or less marginal in several rows; they are slender and tapering, about twice the length of the diameter of oral disk, or perhaps slightly more. Color of tentacles pale grayish or greenish, with dark lateral spots near the base, and with lighter bars or bands toward the distal portion, interspersed with whitish bands or spots (pl. XLII, fig. 6). Oral disk yellowish or white, with darker radial lines; mouth with 15 to 20 rather prominent liplike folds. General color more or less variable; column pale flesh color. When first taken from the water or sand the body is often covered with a sheath of mucous and adherent sand grains. Acontia extruded over various portions of body, but without evident cinclides.

Habitat: The species has been found by me only in burrows on sandy and pebbly beaches usually just about or slightly below low-tide line, and always attached to a smooth cobblestone. In the aquarium it will adhere to almost any smooth support, or even the sides or bottom of the dish or aquarium.

Distribution: The species is accounted rather rare. This may be due in part to the burrowing habit and to the close simulation in color of the tentacles and oral disk as they appear at the mouth of the burrow, rendering difficult its detection unless one looks for it with some care. But I have not found it in any such numbers as to suggest it as a common or abundant species. Verrill reports its distribution from Long Island Sound to Vineyard Sound. I have also taken it in Buzzards Bay adjacent to Woods Hole.

Sagartia luciæ Verrill. [Pl. XLI, fig. 1 and 2.]

Sagartia luciæ Verrill, Am. Jour. Sci., 4th, vol. VI, 1898, p. 493. Parker, Am. Nat., vol. XXXIV, 1900; ibid., vol. XXXVI, 1902, p. 491. Davenport, Mark Mem. Vol.

This beautiful little actinian, formerly a stranger to the fauna of Woods Hole, is now one of the most abundant of the littoral species, occurring almost everywhere—on rocks, eelgrass, fucus, shells, piles, etc. It is a small species, varying from 10 to 18 mm. in height, by about 4 to 6 mm. in diameter. The body is smooth and highly contractile, dull olive greenish in color, with a variable number of vertical yellowish or orange stripes. Tentacles rather numerous, from 25 to 50, in several illy defined whorls, long and delicate, and very contractile, pale greenish, sometimes tinged with whitish. Oral disk variable as to shape and color; usually flat or concave, greenish, or sometimes with darker radial lines, and often with conspicuous bars at base of directive tentacles. It will more often be observed that only a single bar is present. This is due to the fact that a common mode of fission, to be mentioned later, often leaves but one of these bars apparent. Acontia freely extruded through body or mouth.

Reproduction: At certain times sexual propagation is active, and in his original description Verrill states that young embryos might be seen swimming in the cavity of the translucent tentacles. One may also find at certain times in sections of the animal the inclusion in the mesenteries of genital cells. So far as my own observation has gone, however, another mode seems to be of more general occurrence—an asexual one, namely, fission. I have repeatedly observed this process in all stages at almost any time during midsummer. It is not difficult, indeed, to observe the process from its inception to completion, for it goes forward with surprising rapidity, the entire operation occupying from two to three hours, probably often less time. This is most easily studied in small aquaria, or even finger bowls or other glass dishes capable of holding a pint or a liter of water.

Unlike the process which has been described for *Metridium* and a few other species, in which fission begins at the mouth or oral disk and proceeds vertically downward, in *S. luciæ* the very opposite direction is the one invariably followed, at least so far as I have observed. The first evidence of such fission may be noted in an extension of the pedal disk in a plane parallel with the oral axis. If this extension is to initiate the process of fission there will soon be distinguishable the appearance of a constriction of this elongated disk and the organization of a sort of double foot, in which may be seen the radial arrangements of the proximal ends of the mesenteries. The stretching of the disk is followed by a corresponding condition of the walls of the column, a condition which will soon be seen to involve the entire body and oral disk. Careful observation will show a gradual thinning of the basal disk as the stretching goes on more and more, and sooner or later the actual rupture of the bottom of the disk, a rent appearing and passing in a direction at right angles to the oral axis. When this is clearly underway the pulling of the opposite halves of the body continues with increased vigor, and the rent may be followed in an upward and vertical direction, which enables the observer to actually see the inner organs, mesenteries, acontia, etc. A most curious phenomenon may be seen occasionally as the process continues, namely, as the pulling and consequent tearing proceeds there will occasionally be witnessed the explosion and shooting out of acontia, apparently in response to the physical stimulus involved in the rending of the tissues. It is as if at certain times the pulling was too vigorous and the consequent "hurt" more than the creature could stand with equanimity, and the extrusion of the acontia the expression of protest on the part of the

injured tissues. The process goes on usually without interruption till the fission has separated the basal portion completely, the last rupture of the lateral threads occurring with a more or less sudden break and the prompt contraction of the free ends.

The upward fission is fairly rapid, and soon the oral disk and mouth become involved in the operation. The fission is almost invariably finished upon one side at a time; that is, one half seems to yield more readily than the other, and the rending of the tissues of that side may be complete as much as a half hour before that of the other. Indeed, it would seem as if there was something of arrest in the vigor of the pulling when the fission had completed itself throughout one half. As the process of either side approaches completion the last vestige of the oral disk becomes spun out into a delicate thread 5 or 6 mm. or more long, in a tremendous state of tension, the final rupture of which takes place with a more or less sudden rebound of the ends and sides of the body. The final rupture of the other side seems to take place more slowly, but is soon accomplished, when the two halves of the divided actinian assume a more or less erect aspect, fold the edges inward until the opposite edges approximate and finally unite and gradually heal over, each becoming an independent individual. The healing and internal adjustments would seem to be much slower than the fission, appearing to require for completion a day or two, perhaps more in some cases.

That this process of propagation is a normal one and of general occurrence during the summer can hardly be doubted. The immense colonies which may often be found on a given stone, or on a shell of *Mytilus*, could hardly have happened thus by other mode. Furthermore, when one seeks for perfectly symmetrical specimens in a state of nature they are difficult to find. The figure shown in plate XLI, made from a living specimen, illustrates the asymmetry in the single white line connecting the directive tentacle of only one side. But this is not all. Sections of the body show the asymmetry to involve the whole internal organization—mesenteries, siphonoglyphes, etc.

In most cases the species is normally diglyphic; but during the season of asexual propagation this feature is more or less obscured or disguised. Further reference to figure 1 will make this point more evident. I have occasionally found triglyphic individuals, but they are rather unusual. One such was observed undergoing fission, and in this case the process involved very nearly an exact third of the parent body, leaving an unsymmetrical diglyphic specimen. I was somewhat curious to see whether a fission into three individuals at once might not occur, but this did not happen; and though the specimen was followed during two or three succeeding days there was no indication of further fission.

Carlgren (1904) in a recent paper has described experiments and observations on several species of actinians which have interesting features in common with those herein described. On page 77 he gives some account of fission found occurring in nature, and certain of his figures might be duplicated by this phenomenon in *S. luciæ* (e. g., fig. 6, 24, 25, 26, 27, taf. I and II.)

The mesenteries of this species vary greatly in number and arrangement. I had the privilege of looking over a large number of sections made by Mr. D. W. Davis, who has been engaged in experiments upon it, and sought in vain for a single case of what might be regarded as typical hexamerous symmetry.

Distribution: The species was first described by Verrill in 1898. It was first observed at New Haven about 1892, and was then quite rare. Within the past 10 years, to the personal knowledge of the writer, the occurrence of the species at Woods Hole has passed from a condition of comparative rarity to one of extreme abundance. A brief paper by Parker (1902) gives a succinct account of its dispersal along the coast since its first occurrence about New Haven. Apparently the same species has been recently found at Plymouth, England (1908), and a few brief comments made to the effect that instead of having got its introduction into our region and spread from that as a center, the fact would seem to be that it had found distribution from some unknown source and had been simultaneously scattered and established in several remote localities. Mr. Davis has recorded the species at San Francisco, and states that its identity with *S. luciæ* seems beyond question. I looked in vain for it at South Harpswell, Me., in 1909.[a]

[a] The writer identified this species at Naples in 1911, having the same distinctive features of structure, color, mode of fission, etc. This would seem to show that it is probably very widely distributed over the shallower seas.

Habitat: Very general. It seems to find itself at home almost anywhere—on rocks in tide guts, brackish ponds, upon eelgrass, on living shells of *Mytilus*, among colonies of *Molgula* and *Cynthia*, and others too numerous to mention.

Sagartia abyssicola Verrill.

Sagartia abyssicola Verrill, Am. Jour. Sci., vol. XXIII, 1882, p. 314; Bull. Mus. Com. Zool., vol. XI, 1883, p. 45. Parker, Am. Nat., vol. XXXIV, 1900.

Assuming a valid significance in the name of this species, its habitat might seem to carry it easily beyond the scope of this report. It has, however, become so familiar from recent collections, and from depths in no sense abyssal, that it seems very proper to make at least a brief record of its occurrence.

In view of the excellent descriptions and figures given by Verrill (vide supra), there is no occasion for attempting anything of the sort here. Its more usual habitat is the tubes of the annelid, *Hyalinœcia artifax*, but it is occasionally found attached to stones, shells, etc. When brought up in the dredge it is almost invariably contracted into a low conical lump, resembling more or less a small *Metridium* in a state of close contraction. The tentacles are numerous, longer than the diameter of the body, slender, and tapering. Acontia are numerous and protruded freely. The color is usually a dull brown in preserved specimens.

Distribution: Various records show it to be more or less common along much of the coast line, at depths of 50 to 60 fathoms and beyond.

CYLISTA Gosse, 1860.

Cylista leucolena Verrill. [Pl. XLIII, fig. 8.]

Sagartia leucolena Verrill, Proc. Boston Soc. Nat. Hist., vol. X, 1866, p. 336; Inv. An. Vineyard Sound, 1874, pp. 329, 738; Am. Jour. Sci., 4th, vol. VI, 1898, p. 495.
Cylista leucolena Andres, Fauna u. Flora Golfes Neapel, bd. IX, p. 151. Parker, Am. Nat., vol. XXXIV, 1900.

This species is common and abundant throughout the region, but its small size and retiring habits tend to render its presence more or less obscure or even unknown.

The following characteristics may be regarded as diagnostic. Body elongated, cylindrical even in contraction, smooth, or with minute papillæ disposed in scattered but more or less vertical rows. Pedal disk well developed, by means of which the creature may adhere tenaciously to almost any object, and also serving as a means of locomotion. Oral disk concave, mouth with about 10 pairs of corrugations, or lips, which are of a brownish color. Body translucent, enabling one to observe the mesenteries which appear as whitish longitudinal lines within the body. Tentacles rather numerous, 40 to 60 or more, in some three series, the inner longest, all delicate, attenuate at tips. Color usually delicate pinkish or flesh color to almost white, sometimes with a greenish tinge, especially near oral end and bases of tentacles when contracted;[a] tentacles whitish, often greenish at basal ends. Size variable according to age, the average being about 30 to 40 mm. in height by about 5 or 6 mm. in diameter.

In a few points this description does not wholly agree with that of Verrill. For example, the size ranges somewhat smaller, Verrill giving the height as from 50 to 65 mm. Again, his statement that "one of the primary tentacles in the longitudinal plane opposite one end of the mouth is much longer than the others, and often differently colored than the others," I was not able to confirm, except in a rare specimen now and then. Surely it can not be regarded as a diagnostic feature. It was not unusual to find at certain times that one or even several of the tentacles of the inner series might become more

[a] Occasionally an interesting variety of this species is found, distinguished by a marked color difference, specimens being bright or deeply orange colored. A few specimens were taken at Woods Hole and at first taken to be a new species; but a study of sections failed to show any structural distinction of consequence.

Later I received from Miss Anna Luther, of Jersey City, several living specimens which had been taken at Bay Shore, Long Island, and all of the same distinct orange coloration. At this locality the orange color predominates, only an occasional specimen of the white variety occurring. They are quite hardy and live in a balanced aquarium for months if occasionally fed. In this they are quite like the white variety of Woods Hole. So far as I am aware this marked color distinction has not hitherto been pointed out.

or less specialized at times, apparently serving as tactile organs, being greatly extended and vigorously vibrated in various directions. Figure 8, plate XLIII, will give a good general impression of the appearance of the animal.

Habitat: More or less common on rocky or gravelly beaches adhering to the under side of rocks, or in crevices; also found among masses of ascidians on piles of docks, and among colonies of sponges, worm tubes, etc. It is quite susceptible to light and invariably seeks shaded or protected localities. They are much more commonly found under stones along rocky beaches than elsewhere. They are readily adaptable to an aquarium habitat, living in apparently normal vigor for several weeks if some care be taken to provide fairly good water and occasionally some shreds of meat, as bits of shrimp or clam, etc. In this habitat it is quite easy to study the habits of the organism to one's content. Elsewhere I have given some account of their behavior in relation to light intensity, etc. Specimens occasionally adopt a burrowing habit and secrete themselves in sand.

Reproduction: This seems to be wholly of the sexual sort. During several years of fairly close observations I have never seen the slightest indications of budding or fission. Furthermore, the sexes seem to be quite distinct. I have repeatedly undertaken to study the development of the species, but have found it difficult to secure ripe males and females at the same time. Only once have I succeeded in getting early traces of cleavage. Whether the transfer of specimens to the aquarium tends to check the reproductive function I am uncertain. I have repeatedly had eggs deposited in the dishes, and in a few cases sperms were deposited at the same time, but in only one instance have normal fertilization and development followed. I have had a similar experience with other actinians, e. g., *Metridium*, and am disposed to regard the transfer to an artificial condition as tending to check or modify the sexual activity. An examination of sperms obtained under these circumstances showed them to be quite active and apparently normal; but attempts to fertilize eggs liberated at the same time seldom gave any response.

Distribution: This is given by Verrill as from North Carolina to Cape Cod. I have taken them in Long Island Sound and in Vineyard Sound, Buzzards Bay, etc.—a fairly abundant species throughout the entire region.

TEALIA Gosse, 1858.

Tealia crassicornis Muller. [Text fig. 3 and 4.]

Actinia crassicornis Muller, 1776; Gmelin, 1788, 1793, 1798; Johnston, Hist. Brit, Zooph., 1847, p. 226.
Rhodactinia davisii Agassiz, Compt. Rend., 1847, p. 677; Verrill, Mem. Boston Soc. Nat. Hist., vol. I, 1864, p. 18.
Bunodes crassicornis Gosse, Ann. Nat. Hist., 1855, p. 294.
Tealia crassicornis Gosse, ibid., 1858, p. 417; Actinologia Britannica, 1860, p. 209.
Andres, Fauna u. Flora Golfes *v.* Neapel, bd. IX, p. 199.

The synonomy of this species is extremely intricate and confusing. It may be doubted whether in the entire literature of Actiniaria a more complicated case can be found. This may be due in part to the highly variable external features, which have been so largely taken by the early naturalists as diagnostic. No attempt has been made to present more than the briefest outline in the above list. To those who are concerned as to this feature fuller details may be found in the masterful work of Andres (vide supra).

In connection with the above reference to the variable aspects of the species it may be well to cite certain facts. For example, Verrill had long ago pointed out this feature, saying "in form it is very mutable, both ends being capable of great distension or contraction. It will often assume a variety of the most diversified forms within a very few minutes." As to color he makes similar reference: "Deep crimson, mottled with pink; littoral specimens most commonly of a clear bluish-green color, irregularly blotched with crimson or reddish brown." The specimens taken by me, though comparatively few, have shown similar variability, especially as to coloration. I have not observed the extreme variation of form mentioned by Verrill. It should be stated, however, that my specimens were mostly of small size, and being dredged from a depth of some 20 fathoms were more or less contracted, only a few of them living long after being taken and these apparently not extending fully in the aquarium.

In only a few instances have representatives of the species been taken in the region. On two occasions I have taken specimens at Crab Ledge, off Chatham, Mass.; another specimen was taken by Dr. Sumner, late in the summer of 1907, off Gay Head, which was presumably of this species, though unfortunately was not preserved.

The following may be taken as fairly diagnostic characters: Column generally smooth, or with slight papillose bodies variously disposed over the body, more particularly on the upper portion, and in the specimen there was a marginal series of spherular bodies. Pedal disk well developed and larger than diameter of column. Oral disk well defined and with darker radial lines extending toward the margin. Tentacles rather stout, fingerlike, about 50 in number in specimens taken by me, arranged in some three series.

Sphincter strongly developed, and almost diagrammatically comparable with Hertwig's figure of this organ for the genus. (Cf. fig. 4.) I regret that my material was found badly preserved for histological details, so that it has been found impracticable to submit figures of other internal organs. It was not difficult to determine the presence of numerous mesenteries, two siphonoglyphes, and the appropriate directives, as shown in text figure 3.

Reproduction: So far as known this is exclusively sexual. In the cases under observation it was found that earlier development takes place within the gastric cavity of the adult. Several young were brought forth during life in the aquarium in a stage of perfect development, and continued to thrive for some time.

FIG. 3.—*Tealia crassicornis*. Section through two primary, and pair of directive mesenteries; *ent*, entoderm; *ec*, ectoderm; *d*, directive mesenteries.

Distribution: While rather rare within the region the cases given make certain its presence as an integral feature of the fauna. According to Verrill, from Nantucket Shoals to Grand Manan.

ELOACTIS Andres, 1883.

Eloactis producta (Stimpson): [Pl. XLII, fig. 4.]

Actinia producta Stimpson, Proc. Soc. Nat. Hist., Boston, vol. V, p. 110, 1856.
Halcampa producta Verrill, Mem. Boston Soc. Nat. Hist., vol. I, 1862, p. 30.
albida Verrill, ibid., p. 29.
producta Verrill, Inv. An. Vineyard Sound, 1874, pp. 330, 738. Andres, Fauna u. Flora Golfes v. Neapel, bd. IX, p. 106.
Eloactis producta McMurrich, Proc. U. S. Nat. Mus., vol. XVI, 1894, pp. 141–142.
Eloactis producta Parker, Am. Nat., vol. XXXIV, 1900.

Andres (op. cit., p. 106) was the first to express doubt as to the exact generic relations of this actinian and to suggest the probable necessity of establishing a new genus. This suggestion was later

acted upon by McMurrich (vide supra), who proposed its reference to the genus *Eloactis* of Andres. This was later followed by Parker, and following these proposals I have formally accepted this reference. At the same time it should be said that the grounds of the proposed reference to another genus are not altogether conclusive. Whether a given species be hexamerous or decamerous, in view of the range of variation now known to prevail to considerable extent, can hardly be of great significance as a taxonomic feature. While the species under consideration is apparently predominently decamerous, I have found considerable variation in this respect. In younger specimens the hexamerous condition is not at all uncommon. In several different specimens some 50 to 70 mm. in length which I took occasion to section and examine the hexamerous state was prevalent. In very large specimens the decamerous arrangement was quite as prevalent.

The general features of the species will be fairly well shown in figure 4, plate XLII. As will be seen, the body is elongated, more or less cylindrical, and comprises some three distinguishable regions: An oral, retractile portion, or capitulum; a basal, bulbous portion, or pedal-like disk, or physa; and an intermediate portion, the column. This is marked by a series of about 20 longitudinal grooves, whose intermediate ridges are provided with numerous papilliform suckers, by means of which the creature is able to retain itself in the burrow. The length of the body varies greatly, averaging perhaps 100 to 150 mm. in ordinary life. In some cases at full extension it may become twice this length (Verrill). The diameter also varies greatly. It probably averages about 8 to 10 mm. The tentacles are normally 20 in number, with occasional variations, rather stout, with brownish knob-like tips. The color varies from whitish to pale salmon on the column, the base translucent, with bluish tint. A white variety has been described under the name *Halcampa albida;* but this is doubtless a merely varietal character, and in nowise entitled to specific distinction.

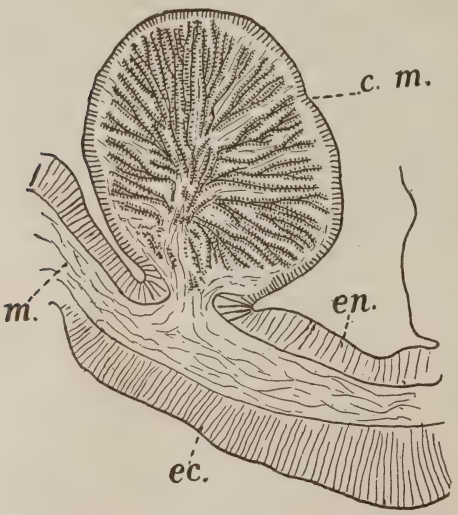

FIG. 4.—*Tealia crassicornis.* Section of circular muscle (*c. m.*); *en* entoderm; *m*, mesoderm; *ec*, ectoderm.

Habitat: The species is characterized in a remarkable degree by the burrowing habit. In many years of observation I have never found it except in burrows on sand flats between tide lines. In this habitat it forms burrows wherein it lives, perhaps more or less permanently. However, it should be said that specimens in the aquarium, in which, by the way, it will thrive for weeks in apparent vigor, yet show a tendency to emerge from the burrows at night and to migrate variously about the aquarium. A further fact may not be without some significance to the same effect, namely, that its burrows do not become lined by a tubular product, such as is provided by *Cerianthus*. I have elsewhere (Biological Bulletin, vol. XII, p. 274) pointed out certain peculiarities of behavior of some significance in this connection, and also as indicating something as to modes of life. That it is markedly sensitive to varying degrees of light, even to the extent of distinguishing between light and darkness, which has rendered the species predominantly nocturnal, seems to be beyond doubt.

These two features, namely, the burrowing and nocturnal habits, conspire to render its presence unknown by most people, except those who especially direct attention to its discovery. While more abundant locally than either *Sagartia modesta* or *Edwardsia elegans* it is yet far from common.

It may be suggested in this connection that the act of burrowing is effected exclusively by the aboral end, or physa. This is bent downward upon the sand, and then by a process of pushing, and at the same time a twisting motion, and by alternate contractions and expansions of the disk, the foot is forced downward. It is by no means a rapid process, and very differently effective by different individuals, as I have elsewhere shown (op. cit.).

Distribution: Verrill reports it from South Carolina to Cape Cod. I have taken it at certain points in Buzzards Bay, and at Catama Bay, and elsewhere about Marthas Vineyard. Its distribution would seem to be more or less local, and dependent upon favorable conditions as to food and for burrowing, etc.

EDWARDSIA Quatrefages, 1842.

Edwardsia elegans Verrill. [Text fig. 5 and pl. XLIV, fig. 12.]

Edwardsia elegans Verrill, Am. Journ. Science, ser. 2, vol. 48, p. 118. Andres, Fauna u. Flora Golf. v. Neapel, vol. IX, p. 95. Parker, Am. Nat., vol. XXXIV, p. 749.

This elegant little actinian is seldom seen except by those who diligently search for it, its burrowing habit giving it effective seclusion.

Body elongate, comprising three more or less distinctive portions, namely, (1) an upper, smooth, necklike portion, of faint brownish color; (2) the body or column, rough from the presence of a sandy accretion over a tough cuticular covering; (3) a somewhat roundish basal portion, translucent or of slightly bluish tint. The entire body is marked by 8 longitudinal grooves or sulcations. Tentacles 16, rather short and fingerlike in moderate contraction, or long and delicately attenuate when fully expanded; apparently of two series, an outer, which is usually depressed close upon the sand at the mouth of the burrow; and a second, alternating series, which extend upward. In color the tentacles are pale brownish, with transverse bars or blotches whitish or pale greenish.

Length of body in expansion 20 to 35 mm., diameter 3 to 5 mm. The organization of the body is shown in the sections taken through the œsophageal region. (Pl. XLIV, fig. 12.)

Distribution and habitat: Found generally throughout the region in favorable sand flats between tide lines, where it burrows. Taken at West Falmouth, Woods Hole, Great Pond, Falmouth, etc.

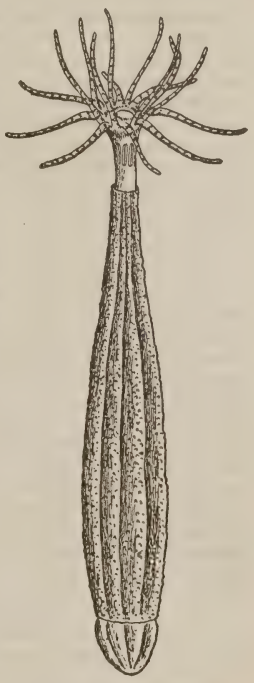

FIG. 5.—*Edwardsia elegans.*

In a paper on the "Behavior of sea anemones" (Biological Bulletin, vol. XII), I have given some account of phases of activity as exhibited by tube-dwelling anemones. At the time this paper was prepared I had not been able to include any account of this species. This was later included in a report upon the reactions of these organisms given at the International Zoological Congress, Boston, 1907. It may suffice in this connection to say that in almost every respect the reactions and behavior of *E. elegans* are comparable with those of *Sagartia* and *Eloactis*.

The species lives well in aquaria and affords a favorable object upon which to observe various aspects of behavior. This is particularly the case with food taking and reactions to varying degrees of light intensity.

Edwardsia sipunculoides (Stimpson) Verrill.

Actinia sipunculoides Stimpson, Marine Inv. of Grand Manan, 1853. *Edwardsia sipunculoides* Verrill, Mem. Soc. Nat. Hist., Boston, vol. I, p. 28, 1864; Andres, Fauna u. Flora Golfes Neapel, bd. IX; Parker, Am. Nat., vol. XXXIV, 1900.

This species has not hitherto been recorded south of Cape Cod. The writer several years ago found a single specimen of an Edwardsia at West Falmouth, Buzzards Bay, which was thought to be *E. sipun-*

culoides, but in some way it was lost before any decisive identification was made, and hence the matter must remain somewhat doubtful. During the present summer (1909) I took a single specimen at South Harpswell, Me., of exactly the same general characters, and conforming so far as distinguishable with the descriptions of Stimpson and Verrill. When first dug out of the sand the specimen was about 50 to 60 mm. in length, of whitish or pale flesh color. After it was placed in the collecting pail along with a few other objects it became greatly contracted and remained in that condition for more than a week in the laboratory, though every means available to induce it to expand was tried. Finally, before leaving it was killed and preserved, and later carefully sectioned in the hope of finding conclusive evidence as to its specific relations. Unfortunately the state of contraction had been so great that the killing proved to have been unsatisfactorily done, and while the main generic features were easily distinguishable it was not practicable to certainly determine the number of tentacles and other specific characters. So far as known only one other species could be possibly confused with it, namely, *E. farinacea*, and it seemed not to have been this. I am strongly convinced that the specimen was *E. sipunculoides*, and that, moreover, the one taken at Woods Hole previously was also this species. Hence it seems altogether proper to include the species as coming within the region.

I much regret that I am not able to present good anatomical descriptions of the species. However, the earlier description of Verrill (vide supra) renders this lack less serious.

Edwardsia lineata Verrill.

Edwardsia lineata Verrill, Inv. An. Vineyard Sound, p. 739, 1874; Andres, Fauna u. Flora v. Golf. Neapel, bd. IX; Parker, Am. Nat., vol. XXXIV, 1900, p. 750.

"Body cylindrical, elongate, covered with dirty brownish, slightly wrinkled epidermis, except just below tentacles, where it is smooth, translucent, and usually with eight longitudinal, flake-white lines showing through. Tentacles 24 to 30, or more in large specimens; slender, tapering, obtuse, white or pale flesh color, each with a flake-white longitudinal line along inner side. Disk with white circle around the mouth, and often with eight or more radiating white lines extending to the base of inner tentacles; border of mouth somewhat pale red; naked part of column pale flesh color, often with circle of white below bases of tentacles. Length 25 to 30 mm., diameter 2.5 to 3 mm. Species remarkable in lacking any naked basal portion, or any true disk for attachment. This may be due to the peculiar habit of nestling in crevices between rocks, worm tubes, etc. Off Gay Head, 6 to 12 fathoms, among ascidians and annelid tubes, etc. Abundant."

I have not seen this species, and the above description has been compiled from that of Verrill. Having been on constant lookout for the species for several years, it seems rather strange not to have obtained a single record of its occurrence.

Edwardsia leidyi Verrill.

Edwardsia leidyi Verrill, Am Jour. Sci., ser. 4, vol. VI, p. 493; Parker, Am. Nat., vol. XXXIV, 1900, p. 750.

This remarkable Edwardsian was first noted by A. Agassiz as a parasite in *Mnemiopsis leidyi* and taken to be a leechlike worm. (Cf. Catalogue of North American Acalephæ, p. 23.) It was later observed by Verrill. (Invertebrate animals of Vineyard Sound, p. 457.) Its true character seems first to have been recognized by Mark. (Memoirs of Museum Comparative Zoology, vol. IX, p. 43.) Mark also pointed out the fact that this stage was a larval one, and that during this period it was a true parasite within the ctenophore. Following the development so far as conditions made it possible, he suggested that the larva might not improbably be a stage in the life history of *Edwardsia lineata*. To the present writer it seems rather more probably related to *E. elegans*. As evidence of this may be noted the number of tentacles in Mark's oldest specimen, namely, 16, while in *E. lineata* the number is from 24 to 30, or more. Again the aspect of the tentacles is very much like that of *E. elegans*.

It is much to be regretted that as yet we are without a final account of the life history, no later observer having been able to carry the record beyond that at which it was left by Mark. The present writer has sought to discover some clue to the later stages, but without success. The occurrence of the larvæ is most erratic. During some seasons it abounds to such extent that hardly a specimen of Mnemiopsis can

be found without from one to a half dozen or more of the parasites within the canals, and during other summers scarcely a single specimen can be found at all. During the entire summer of 1907 the writer sought from June to September for larvæ, but without finding a trace. In November of the same year Mr. Vinal Edwards and Dr. Sumner found them in immense numbers, almost every ctenophore being infected.

Morphology of the larval stage: Polyp slender and wormlike, and variously coiled in the canals of the ctenophore. Length of larger specimens 20 to 30 mm., diameter 1 to 2 mm., varying under conditions of contraction. Tentacles 16 (?), color pinkish or flesh color.

CERIANTHUS Delle Chiaje, 1841.

Cerianthus americanus Verrill. [Pl. XLIV, fig. 10.]

Cerianthus americanus Verrill, Mem. Boston Soc. Nat. Hist., vol. I, 1866, p. 32; McMurrich, Jour. Morph., vol. IV, 1890, p. 131; Parker, Am. Nat., vol. XXXIV, 1900, p. 756.

Originally described by Verrill from a southern habitat, this species has but rarely been found at Woods Hole. The writer found a single specimen several years ago, but failed to secure it. In a collection of *Edwardsia* taken at Ram Island, Woods Hole, in 1902, there was found a single specimen which was turned over to the writer for identification. It resembled at first a specimen of *Sagartia leucolena*, or a very small specimen of *S. modesta*. A careful examination of the specimen, however, proved it to be an immature specimen of *Cerianthus*. The size was only about 35 mm. in length by about 5 mm. in diameter, in contraction. Sections showed no signs of gonads, and there were but 45 to 50 tentacles; all of which go to show a condition of immaturity. The sectional figures were made from the specimen and leave no doubt as to its identity.

The specimens originally described by Verrill were of very large size—2 feet or more in expansion. McMurrich, who has studied specimens from the same general region, has not been able to confirm Verrill's account as to size. Specimens examined by the writer from the Woods Hole region agree very closely with McMurrich's account in this particular. His account gives the length as not more than 20 cm., with a diameter of 1.5 to 2 cm.

In the matter of color there seems to be considerable variation. The specimen from which this account is chiefly derived was in life translucent and pale flesh color. Another specimen examined by the writer was brownish, especially near the oral portion, the aboral region being paler. A purplish tint is not unusual along with the brown.

Habitat: This seems to be almost exclusively at or just below average tide line and in muddy flats. The species is of burrowing habit, these burrows extending at an angle for considerable depths. The creature secretes a tubular lining for its burrow, which is composed of mucus secreted by ectodermal glands, in which are also agglutinated extruded nematocysts, grains of sand, etc. In the aquarium the specimens also secrete a similar tube, but, according to McMurrich, of much lighter texture.

ACTINAUGE Verrill, 1883.

Actinauge verrilli McMurrich.

Actinauge nodosa, Verrill, Am. Jour. Sci., vol. VI, 1873, p. 440; Bull. Mus. Comp. Zool., vol. XI, 1883, p. 50.
Actinauge verrilli, McMurrich, Proc. U. S. Nat. Mus., vol. XVI, 1893, p. 184.

Among the collections at Woods Hole I found four specimens of this species, two of which were taken by the *Albatross* in 1885 at station 2506 from a depth of 27 fathoms. The other two were taken by the *Fish Hawk* in 1899 at station 7070. These specimens differ more or less in general external features. The *Albatross* specimens (contracted) measured 5 and 7 cm. in height by about 4 and 5 cm. in diameter. The warty nodules, or verrucæ, were very prominent and characteristic. They were disposed in about 24 longitudinal rows in the smaller specimen. The capitular ridges were somewhat less evident and definite but about 40 in number. The larger specimen was much more contracted, making it impracticable to determine exactly the number and disposition of these structures, but the longitudinal rows seemed to be about 28 in number.

In the *Fish Hawk* specimens the verrucæ were much less prominent, and the capitular ridges and longitudinal rows likewise indistinct and correspondingly indefinite. They appeared, therefore, of smoother and cleaner texture than the former, which were rough and the furrows and nodular interstices coated with a brownish deposit in marked contrast to the whitish points of the nodules themselves.

While this species is seldom seen among the fauna of the region as strictly interpreted, still it has seemed quite proper to make at least a brief reference to their presence among contiguous fauna.

MADREPORARIA.

Of the Madreporaria there are comparatively few species which come within the range of the present synopsis. Of these by far the most common is *Astrangia*, which abounds almost everywhere. The more characteristic features of the order have been given in an earlier section.

ASTRANGIA M. Edwards and Haime.

Corallum forming an encrusting mass over the substructure, the colony forming variously disposed aggregates of polyps, mostly of small dimensions, though occasionally branching in rather complex fashion, as shown in figure 9, plate XLIII. The polyps are very transparent, but appear white as viewed against a dark background.

Astrangia danæ Agassiz. [Pl. XLIII, fig. 9.]

Astrangia danæ Agassiz, Proc. Am. Assoc. Adv. Sci., vol. II, p. 68, 1847; Milne-Edwards and Haime, Ann. des Sci. Nat., 3d ser., T. XII, 1850.
Astrangia astreiformis Leidy, Jour. Acad. Nat. Sci., vol. III, 1855, p. 239.
danæ Verrill, Mem. Boston Soc. Nat. His., vol. I, 1864, p. 40; Inv. An. Vineyard Sound, 1874, p. 740.

This is the best-known coral, having a natural habitat within the region. Indeed, it is the only one at all familiar along the shore waters of the New England coast. It occurs almost everywhere, growing on rocks, piles of docks, shells, etc., at or just below low-water line to a depth of 15 to 20 fathoms. Its range is given as from Florida to Cape Cod. It has also been reported from the waters of Casco Bay, Me. The species forms irregular incrustations of rather small dimensions over shells, rocks, etc., though it occasionally becomes larger and branches in rather complex fashion. It lives well in the aquarium for an indefinite time. Polyps in expansion about 10 to 15 mm. in height and with about 24 delicate tentacles, which bristle with nematocysts, especially about the tips. Cells of the corallum rather shallow and with numerous septa, as shown in the figure. The breeding season seems to be chiefly in midsummer. I have occasionally obtained eggs in the aquarium but it has been found difficult to secure them under conditions favorable for development.

ORBICELLA Dana, 1846.

Orbicella acropora (Linnæus).

Madrepora acropora Linnæus, Syst. Nat., X ed., p. 708.
Madrepora annularis Ellis & Solander, Nat. Hist. Zooph., 1786, p. 169.
favevolata Ellis & Solander, op. cit., p. 166.
Heliastrea annularis M. Edwards & Haime, Hist. Nat. Corall., vol. II, p. 473, 1857.
acropora Milne-Edwards & Haime, op. cit., p. 477.
Astrea annularis Lamarck, An. sans Vert., 2d ed., vol. II, p. 405.
Orbicella annularis Pourtales, Mem. Mus. Comp. Zool., vol. VII, 1880; A. Agassiz, Bull. Mus. Comp. Zool., vol. XX, p. 61, 1890.
acropora Vaughan, Bull. U. S. Fish Comm., vol. II, p. 301, 1901.

A fragment of this coral was found by Dr. F. B. Sumner on the beach at Nobska (Woods Hole) in July, 1906, and still another some two years later. Both specimens were somewhat worn by water action, yet easily identified. So far as known, the species has not hitherto been recorded north of Bermuda, Porto Rico, or similar range. And while at first I was disposed to regard its occurrence here as accidental, possibly through tourist agency, still the facts seem to warrant recording, leaving to

subsequent events the determination of its relation to the region. The specimen measured about 50 by 85 mm., and while more or less eroded was in good state of preservation. The extended dredgings made in the waters of Vineyard Sound for many years would seem to have made more or less certain its discovery if native to these waters. Vaughan's description of the species from Porto Rico gives no account as to depth from which taken, but merely the locality (Mayaguez) and from reef. Its habitat is probably quite shallow, and the course of the Gulf Stream in the region of Woods Hole might warrant its northern range. However, speculation is uncalled for; the facts are given for what they are, as suggested above.

ALCYONARIA.

The alcyonarian fauna of the region is so limited in species as to call for only passing notice. At most but two or three species are represented—one under the genus *Alcyonium* and perhaps two under the genus *Penatula*. In the deeper waters adjacent to Nantucket and off Marthas Vineyard the group has numerous representatives, accounts of which may be found in the reports of the dredging operations of the *Albatross* and *Fish Hawk* from 1880 to 1898. But as recent collections have added no additional facts, either as to species or distribution, it will suffice to call attention to the above reports.

It seems well to briefly describe the two species more likely to be met with by the student, though without attempting details as to structure and habits.

ALCYONIUM Linnæus, 1758.

Linnæus, Syst. Nat., Ed. x, vol. 1, p. 803.
Dana, Zoophytes, 1846, p. 611.
Milne-Edwards, Corallines, 1857.

Corallum fleshy, with granular spicules which do not project beyond the surface; base more or less enlarged and adherent to rocks, shells, etc. Colony variously branched, the branches thick and fingerlike, stem more or less devoid of polyps, which are abundant on the branches and terminal portions, and retractile within the cœnosarc.

Alcyonium carneum Agassiz.

Halcyonium carneum Agassiz, Proc. Am. Assoc. Adv. Sci., 1850, p. 209.
Alcyonium digitatum Stimpson, Marine Inv. Grand Manan, 1853, p. 7; Smithsonian Contr., vol. VI.
Alcyonium carneum Verrill, Mem. Boston Nat. Hist., 1866, vol. I; Inv. An. Vineyard Sound, p. 497, 737.

This conspicuous alcyonarian is well known to almost every collector along the New England coast who has paid attention to the cœlenterate fauna to any extent. It is rather common from Vineyard Sound northward to Maine and beyond, occurring on rocks, shells, etc., and in depths of from 10 to 30 fathoms. It shows small adaptability to aquarium conditions, soon dying when placed therein. The color is variable, from pale flesh color to bright pink or reddish or orange. The colony is branched variously, the branches thick and fingerlike, from which probably arose the common name, "dead men's fingers," often used by fishermen. The stem is attached by an expanded base to any convenient support, such as shells, etc. Polyps variously distributed over upper portions of stem and branches, and in expansion rather conspicuous, having a length of from 7 to 10 mm.; they are highly contractile, and capable of entire retraction within the cœnenchyma. The tentacles are eight in number, beautifully fringed with delicate lobes so characteristic of the order.

PENNATULA.

Pennatula aculeata Danielson and Koren.

Pennatula aculeata Danielson and Koren, Forhandl. Vidansk. Selsk, 1858; same authors, Fauna Litt. Norv., III, 1877. Verrill, Am. Jour. Sci., 1873.

This species was taken by the *Fish Hawk* at several stations off Marthas Vineyard and Block Island in 1882 and 1899, several specimens being now in the collection at Woods Hole. This is a well-known and very beautiful pennatulid; stems usually bulbous at base, the bulb larger at the proximal end,

rachis rather larger in median portion; general shape featherlike, hence the name; polyps borne on upper portion of the pinnæ. The colony varies in size from 10 to 25 cm.; color beautiful purplish red, bulb whitish and opaque in preservation. Species widely distributed over both eastern and western Atlantic and along the entire New England coast and south to Chesapeake Bay.

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DESCRIPTION OF PLATES.

PLATE XLI.

FIG. 1. *Sagartia luciæ*, general view from side. × 2.

FIG. 2. *Sagartia luciæ*, oral view, showing whitish lines marking position of œsophageal grooves, and on the left the evidence of recent fission of specimen as shown in dim outlines of the disk markings.

FIG. 3. *Anemonia sargassensis*, drawn and colored from life, showing also the clasping aspect of pedal disk.

PLATE XLII.

FIG. 4. *Eloactis producta*, drawn and colored from life, showing the expanded disk, the smooth, pinkish lower and papillose upper portions of the column.

FIG. 5. *Sagartia modesta*, drawn and colored from life, showing expanded pedal disk, numerous tentacles, and the sinuous aspect of body as freely expanded in aquarium.

FIG. 6. Single tentacle of specimen, showing characteristic markings. × 3.

PLATE XLIII.

FIG. 7. *Sagartia modesta*, photograph from life as expanded in aquarium, the pedal disk attached to bottom under layer of sand.

FIG. 8. *Cylista leucolena*, photograph from life, in aquarium.

FIG. 9. *Astrangia danæ*, an unusually large coral mass of this species. × ½.

PLATE XLIV.

FIG. 10. *Cerianthus americanus*, section through œsophagus, showing groove and numerous mesenteries and their distribution; *oe*, œsophagus; *ec*, ectoderm.

FIG. 11. *Cylista leucolena*, section through œsophagus, showing paired grooves, mesenteries, and directives (*d*), and secondary mesenterial buds.

FIG. 12. *Edwardsia elegans*, section showing distinctive mesenteries and paired directives (*d*); *oe*, œsophagus; *ec*, ectoderm.

FIG. 13. *Anemonia sargassensis*, section through œsophagus, showing primary mesenteries and numerous secondary mesenterial buds; *d*, directive mesenteries; *ec*, ectoderm.

Fig. 2. Sagartia luciae
Oral view

Fig. 1. Sagartia luciae
Side view

Fig. 3. Anemonia sargassensis

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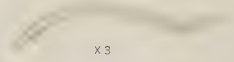
Fig. 4. Eloactis producta



X 3

Fig. 6.

Fig. 5. Sagartia modesta

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Fig. 8.—Cylista leucolena.

Fig. 7.—Sagartia modesta.

Fig. 9.—Astrangia danæ.

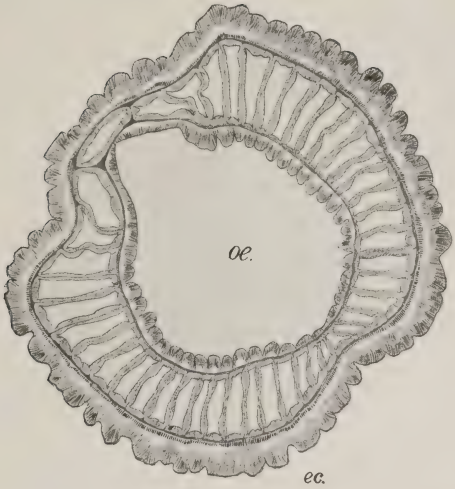

FIG. 10.—Cerianthus americanus.

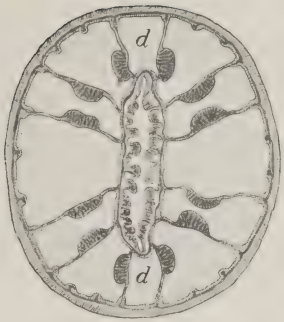

FIG. 11.—Cylista leucolena.

FIG. 12.—Edwardsia elegans.

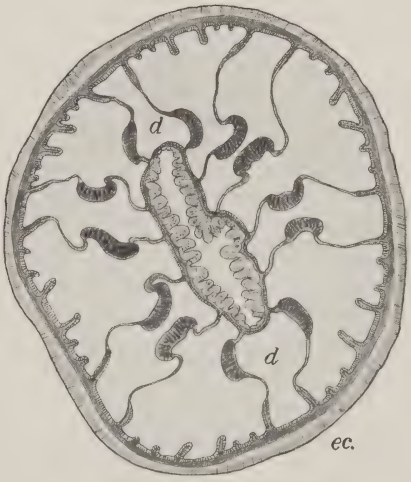

FIG. 13.—Anemonia sargassensis.